Instituto Politécnico de Portalegre

Escola Superior de Tecnologia e Gestão

Recolha de Veneno de Abelha: Estudo de Mercado e Análise da Produtividade e Rentabilidade de um novo Coletor Intensivo no Mercado Português

Dissertação para obtenção do grau de mestre em

Gestão de PME

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Resumo

As colmeias de abelhas proporcionam vários produtos passíveis de serem explorados com interesse e valor comercial. A utilização dos produtos apícolas é vasta e diversa, para fins alimentares, cosméticos e terapêuticos, sendo crescente a Apiterapia nas sociedades ocidentais.

Os objetivos deste trabalho são a análise do mercado português a nível de conhecimento sobre o veneno de abelha – apitoxina – e correspondentes coletores, o desenvolvimento de um protótipo de coletor intensivo e a análise do seu interesse comercial.

Com recurso a um questionário, que foi disponibilizado em associações de apicultores a nível nacional e *online*, foram recolhidos os dados necessários para o esclarecimento das questões relacionadas com o mercado português propostas neste trabalho.

Com base na análise dos problemas reportados relativamente aos coletores de apitoxina existentes no mercado, desenvolveu-se um protótipo de um coletor intensivo, que foi objeto de uma análise comparativa, relativamente a um dos modelos considerados mais eficientes existente atualmente no mercado, no que se refere à sua produtividade e rentabilidade.

Com base nos resultados obtidos pretende-se contribuir para a divulgação e desenvolvimento do mercado da apitoxina em Portugal.

Palavras-chave: apitoxina, coletor de apitoxina, análise de produtividade e de rentabilidade

Abstract

Bee hives provide various products that can be exploited with interest and commercial value. The use of beekeeping products is vast and diverse for food, cosmetic and therapeutic purposes, and apitherapy is growing in western societies.

The objectives of this work are the analysis of the Portuguese market in terms of knowledge about bee venom - apitoxin - and corresponding collectors, the development of an intensive collector prototype and the analysis of its commercial interest.

Using a questionnaire, which was made available to beekeepers associations at national and online level, the necessary data were collected to clarify the issues related to the Portuguese market proposed in this work.

Based on the analysis of reported problems with respect to apitoxin collectors on the market, a prototype intensive collector was developed, which was the subject of a comparative analysis, against one of the most efficient models currently available on the market, in terms of productivity and profitability.

Based on the results obtained it is intended to contribute to the dissemination and development of the apitoxin market in Portugal.

Keyword: apitoxin, apitoxin collector, productivity and profitability analysis

Lista de Acrónimos

FNAP - Federação Nacional de Apicultores em Portugal

HIV - Vírus da Imunodeficiência Humana

PAN – Plano Apícola Nacional

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CAPÍTULO I – INTRODUÇÃO

1.1. Contextualização da investigação

O presente estudo foi desenvolvido no âmbito do Mestrado em Gestão de PME para obtenção do correspondente grau de mestre, incidindo sobre um dos produtos suscetíveis de serem obtidos no âmbito da atividade apícola, o veneno de abelha – apitoxina.

O tema do estudo resultou de um interesse pessoal no desenvolvimento da atividade apícola, praticada como passatempo pela autora, como forma de perceber se é possível torná-la numa atividade mais lucrativa.

Neste sentido, tentou-se caraterizar o mercado português relativamente à apitoxina, desenvolveu-se um protótipo de um equipamento intensivo para a sua recolha e realizou-se uma análise comparativa, relativamente a um equipamento atual, da sua produtividade e viabilidade económica no mercado português.

No que concerne ao mercado português, na apicultura apenas o mel é explorado pelos apicultores portugueses de uma forma relevante. No entanto, existem outros produtos suscetíveis de serem explorados nesta atividade, de entre os quais o menos conhecido é o veneno de abelha, também denominado de apitoxina, possuindo uma vasta aplicação tanto na indústria farmacêutica (Basa, Belay, Tilahun, & Teshale, 2016; Silva, et al., 2015) como na indústria da cosmética (Han, Pak, Nicholls, & Macfarlane, 2016; Lee & Bae, 2016). Devido às suas propriedades únicas (Bogdanov, 2017), é uma substância muito procurada por ambas as indústrias, e com um valor comercial elevado face à sua escassez no mercado (FNAP, 2017).

Devido a ser um produto pouco conhecido, de só se poder extrair pequenas quantidades por colmeia, sem ser de uma forma contínua, de exigir a utilização de um equipamento específico, entre outras razões, considerou-se que existe um potencial interessante de desenvolvimento das condições da sua exploração.

Com efeito, a sua recolha é efetuada com recurso a coletores específicos, existindo vários modelos no mercado. Todos os coletores são compostos por filamentos elétricos sobre uma placa de vidro, que são alimentados por uma bateria combinada com um sistema de pulsos elétricos. As abelhas ao entrarem em contato com os filamentos recebem uma ligeira descarga elétrica, que as faz libertar o veneno na placa de vidro como medida de defesa. A descarga elétrica é utilizada única e exclusivamente para

importunar a abelha, não lhe provocando qualquer tipo de dano físico. Como o sistema é controlado por um sistema de pulsos, só existe carga elétrica nos filamentos durante períodos pré-definidos (Dantas & Nunes, 2014). Este processo de recolha de apitoxina tem o inconveniente de provocar estresse nas abelhas, que pode afetar a produção de outros produtos essenciais à colmeia e, consequentemente, levar ao seu colapso (FNAP, 2017). De forma a verificar a veracidade deste risco, várias entidades procederam a diversos estudos sobre o tema, de onde se concluiu que se a apitoxina for retirada de uma colmeia em dias intercalados, por períodos diários de 30 min a 60 min, não existe um impacto significativo nem nas abelhas nem na colmeia (Modanesi, 2012).

Outro problema enfrentado na exploração deste produto, deriva da existência de uma vasta gama de modelos de colmeias em todo o mundo, cada um desenvolvido para se adaptar ao tipo de abelha existente em cada país, ao nível de produtividade passível de ser obtida, ao tipo de floração e ao clima. Em Portugal verifica-se uma predominância de três tipos de colmeias com diferentes dimensões, cuja utilização varia consoante as zonas do país.

O facto de existirem diferentes tipos de colmeia faz com que existam vários tipos de coletor de apitoxina, que nalguns casos não possuem as dimensões apropriadas para se ajustar a todo o tipo de colmeias, sendo muitas vezes necessário recorrer a medidas corretivas para maximizar a produtividade do equipamento (Han, Han, & Lee, 2014; Sang-Mi, et al., 2005; Abou-Shaara, Al-Khazim, & Ibrahim, 2012; Ahn, 2012).

Esta realidade em conjunto com as escassas quantidades que se obtêm de apitoxina por colmeia, com base nos equipamentos atuais, conduziu à tentativa de conceber um novo modelo de coletor, que se revelasse intensivo, de forma a permitir aumentar as quantidades recolhidas.

Em concordância com os considerandos apresentados, para o desenvolvimento deste estudo definiram-se os seguintes objetivos:

- O1: Análise do mercado português relativamente ao seu conhecimento sobre a apitoxina;
- O2: Análise do interesse dos apicultores portugueses na recolha de apitoxina;
- O3: Desenvolver um protótipo de coletor intensivo de apitoxina;
- O4: Análise da produtividade e viabilidade económica do protótipo.

1.2. Metodologia da Investigação

Como referido anteriormente o mercado da apitoxina é quase inexistente em Portugal, não existindo informação disponível sobre esta prática. Para se contribuir para colmatar esta falha de mercado desenvolveu-se o presente estudo. Recorrendo-se a um questionário como metodologia de investigação sobre esta temática, distribuído através de plataformas *online* de várias associações de apicultores pelo seu baixo custo, facilidade de utilização, rapidez e por ser um meio que permite chegar a uma ampla área geográfica, procurou-se recolher dados junto dos apicultores portugueses. Esta técnica utiliza-se quando o estudo em causa pressupõe uma análise quantitativa de dados (Quivy & Campenhoudt, 2018). O questionário é composto por várias questões de resposta fechada, formuladas de forma clara e inequívoca, para uma melhor análise dos dados recolhidos. De forma a aumentar a credibilidade dos dados recolhidos, escolheu-se uma amostra aleatória de apicultores portugueses, sendo posteriormente estratificada por regiões. Os objetivos da aplicação do questionário foram a avaliação do nível de conhecimento dos apicultores sobre apitoxina, a sua recolha e o, eventual, interesse em dedicar-se a esta prática.

Em Portugal utilizam-se usualmente colmeias do tipo Reversível e do tipo Lusitana, que possuem a mesma dimensão em termos de largura e comprimento variando a altura, assim sendo desenvolveu-se um protótipo de coletor intensivo de recolha de apitoxina com as dimensões de uma colmeia Reversível, para melhor se ajustar às necessidades dos apicultores portugueses. O protótipo desenvolvido foi sujeito a uma experiência comparativa com um modelo atual e considerado dos mais eficientes, tendo-se analisado as respetivas produtividades e rentabilidades no contexto nacional, para recolha de dados necessários para um estudo de viabilidade económica.

Para a análise de viabilidade económica teve-se por base a comparação entre as produtividades e os resultados estimados na exploração de apitoxina num determinado período de tempo. Através desta análise foi possível determinar os indicadores económicos que possibilitaram avaliar a exequibilidade do projeto (Breia, Pereira, & Mata, 2014).

Os indicadores utilizados para análise da viabilidade económica foram a Taxa Interna de Rentabilidade (TIR), o Valor Atual Líquido (VAL) e o *Payback* (tempo de retorno do investimento). O VAL consiste no valor que resulta da atualização dos *cash flows* ou fluxos de caixa para o momento de arranque do projeto. É utilizado para

comparação de diferentes alternativas de investimento, já que permite comparar projetos com diferenças ao nível dos momentos de investimento e ao nível dos retornos. A TIR é a taxa de rentabilidade do projeto que se torna útil para comparação com taxas alternativas de utilização do capital a investir. O *Payback* que nos indica quantos anos são necessários para pagar o investimento no projeto, ou seja, quantos anos são necessários para termos *cash flows* acumulados atualizados maiores que zero (Breia, Pereira, & Mata, 2014).

1.3. Apresentação da Investigação

Com base no que foi exposto, desenvolveu-se um artigo científico através de um conceito de inovação aberta, para que toda a comunidade científica pudesse beneficiar deste estudo. Neste sentido, escolheu-se a revista "*Journal of Open Innovation: Technology, Market, and Complexity*", onde foi publicado o presente estudo ao qual foi atribuído o número 5, 71, no dia 16 setembro de 2019, sob o título "*Productivity and Economic Analysis of a New Intensive Collector in the Portuguese Market with Implication of Open Innovation Perspective*". É uma revista internacional científica de livre acesso, que publica trimestralmente artigos sobre empreendedorismo, inovação, modelos de negócios, complexidade e mudança evolutiva na economia, que desde maio de 2018 é publicada pelo MDPI. O MDPI é um organismo que promove o intercâmbio científico de livre acesso, em diferentes formatos e diversas áreas, desde 2008, sendo indexado no *Scopus*, a maior base de dados de resumos e citações. No ranking da *Scopus* é a 4º melhor revista na área de economia geral, econometria e finanças, com um *CiteScore* em 2018 de 4,26, e um SNIP (*Source Normalized Impact per Paper*) em 2018 de 2,138 e com um percentil de 98%. Sendo o *CiteScore* o que mede as citações médias recebidas por um documento publicado em série e o SNIP o impacto normalizado da fonte por artigo, que mede as citações reais recebidas em relação às citações esperadas em artigos publicados em série.

1.4. Estrutura do trabalho

O estudo é apresentado sob forma do artigo referido na seção anterior e ao longo de sete seções. Para além do *abstract*, na seção 1 introduziu-se o tema. Na seção 2 descreveu-se o mercado português relativamente à recolha de apitoxina. Na seção 3

apresentaram-se a metodologia utilizada para a recolha de dados sobre o mercado português, a forma como se desenvolveu o protótipo de um coletor intensivo e os testes comparativos realizados entre dois coletores de apitoxina. O protótipo desenvolvido durante este estudo e um outro existente no mercado, de forma a se perceberem os rendimentos que podem ser obtidos com cada um deles. Na seção 4 apresentaram-se os resultados obtidos através da aplicação de um questionário aos apicultores portugueses, bem como os resultados dos testes experimentais realizados com os coletores. Na seção 5 apresentou-se a análise da produtividade e da rentabilidade dos dois coletores. A discussão dos resultados obtidos encontra-se na seção 6. Para além das conclusões na seção 7 o artigo também contém as referências utilizadas e a estrutura do questionário em anexo.

CAPÍTULO II - ARTIGO

Journal of Open Innovation: Technology, Market, and Complexity

Article

Productivity and Economic Analysis of a New Intensive Collector in the Portuguese Market with Implication of Open Innovation Perspective

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Abstract: Bee venom is a sub-product of the beekeeping activity, and has a wide field of applications in several pivotal markets. Nevertheless, its collection is not an activity disseminated among Portuguese beekeepers, as its production is marginal. There are limited empirical studies on the production and the technical aspects involved in this type of activity. Our study, therefore, contributes to narrowing this knowledge gap, by analyzing and comparing the productivity and profitability of two bee venom collection techniques. The first involves equipment available on the market, and the second involves a new device developed from the aim of the present work. Concerning market knowledge, a questionnaire was given to a sample of beekeepers, to understand and characterize the market's needs and the level of information about bee venom. Because of the growing market interest in this product, a new collector is proposed, based on a set of intensive frame collectors strategically placed inside the beehives. The improvements obtained were increased production, either in terms of quantity or quality, obtaining a positive profitability. To evaluate the productivity of the proposed equipment, a comparison was performed, in an apiary, between existing state-of-the-art equipment and the proposed intensive collector. In a second stage, the profitability of the new proposed equipment was analyzed, using a comparative method between incomes and costs associated with both solutions. The results obtained showed that the new intensive collector enables a profitable collection of bee venom in Portugal, despite its higher initial investment.

Keywords: natural resources; bee venom production; productivity analysis; profitability analysis; product development

1. Introduction

Beekeeping is an activity directly linked to agriculture, since about 45% of world food production depends on pollinators, with a significant impact on national economies. Besides the pollination, this activity has the purpose of exploring various products of interest and commercial value, namely bee venom or apitoxin [1]. Since the poison is produced by honey bees, and as it is composed of several proteins, such as amino acids, lipids, organic acids, and enzymes [2], several applications arise. Because of this richness, apitoxin has been extensively studied and sought over the years, especially after its therapeutic characteristics when used responsibly have been proven. (When used incorrectly it can lead to allergic reactions of different intensities [3,4]). In fact, the target product of this study is

used in the pharmaceutical industry, in the treatment of several diseases [4,5], such as cancer [2,6,7], HIV, multiple sclerosis, arthritis, bursitis, tendonitis, dissolution of scar tissue, herpes zoster, joint diseases and rheumatoid arthritis, Lyme disease, and osteoarthritis [8]. Another field of application is the cosmetics market [9–11].

Although bee venom has several important applications in Portugal, it is almost a non-existent market. The main reason is due to internal policies that did not establish legislation, or take the necessary measures for its development on beekeeping activity over the years [1]. Beekeeping is an ancient activity from which it is possible to collect various products, such as honey, pollen, propolis, royal jelly, and bee venom, but in Portugal, the only product that is significantly explored is honey [1,12,13]. This problem is not exclusive to Portugal; the European Parliament published a technical report [14], asking for a European Parliament Resolution, due to, among other reasons, the lack of data available about this subject, both in terms of quantity and quality.

Based on the above, it can be seen the importance and interest of bee venom's collection, implying the need for an increasing production with more beekeepers dedicated to this practice [15]. This situation represents a challenge/opportunity to promote bee venom collection and develop more productive collector devices, with evidence that a profitable activity can be archived.

With this study, we seek to set up new processes by which new technologies can be adopted by a group of corporations or companies, and how they can be used to create new products or processes. The purpose is to increase the knowledge among all stakeholders and dynamically analyze the economic impacts of adopting new tools for bee venom production under an open innovation perspective [16].

To measure the level of information concerning bee venom among beekeepers, a questionnaire was drawn up and supplied for answering. With these data it was intended to also evaluate the market interest and potential growth. In relation to the collection of bee venom, specific equipment is used, composed of a glass plate overlaid with metal filaments, which are fed by a power unit combined with an electrical pulse system [17]. There are several different pieces of equipment on the market that are used both inside and outside the beehives [18].

For exterior collectors [19,20], which are placed outside the beehive, the number of bees exposed to the collector is greatly reduced, since it only affects the bees that enter and leave the hive, causing the production of small quantities of bee venom. To extract 1g of venom, 10 hives would be required, an hour per day, adequately placed [21]. Another drawback is the fact that the bee venom is exposed to weather conditions and other contaminants, and, when it is raining, this type of equipment cannot be used [22,23].

Collectors placed inside the beehive are used at the base of the nest [19], or as a cover of the beehive [24]. This type of device can collect more than the outside collectors, since it is able to be in contact with a greater number of bees, while maintaining their normal activity. However, the collectors placed in the base are subject to contamination with the waste of the bees. On the other hand, the cover ones, although with a lower risk of contamination, have the limitation that the collector area is restricted by the down face size, because it works as a cover at the top of the beehive [24].

To respond to the identified problems, the present work studies the design of an intensive collector that will take the form of a set of frames, as the usual honey enclosures, to be placed strategically inside the beehive.

The achievements obtained are a larger collection area and a cleaner substance. Consequently, the potential of obtaining a higher yield from this activity is augmented, due to the increase of production and quality (cleanliness) of the collected product.

The paper is organized as follows. Section 2 presents the Portuguese market and in particular the situation regarding bee venom. Section 3 formulates the methodologies used to collect data the market under scrutiny, the necessary information data to characterize the productivity of the two collectors, both placed inside the beehive, in order to perceive the yields that can be generated with each of them. Section4presents the results obtained from a questionnaire applied to the beekeeper

community, and from the experimental tests made on both collectors. In Section 5 the productivity and profitability analysis is presented, and, the results obtained from the different collectors are discussed in Section 6. To end, Section 7 presents the final conclusions, and future actions, to improve market penetration of the proposed equipment.

2. Portuguese Market Case

The beekeeping sector, in Portugal, is mostly made up of small beekeepers and is directly related to agriculture. The agents of this sector use it, mainly, as a complement of income of the farms, or for self-consumption. It is an activity that is responsible for pollination of agricultural crops, contributing to a significant increase in the yield of farms and, also, for the preservation of biodiversity [1,12,13]. There are more products that can be explored in beekeeping in addition to honey, such as pollen, propolis, royal jelly, and bee venom. Due to the fact that the beekeeping labor force is not specialized, with few resources, scarce management practice, and little technical knowledge in the area, it is an underdeveloped activity [1,15].

All beekeeping products, except honey, are unknown to the common consumer, due to the lack of available information about them, and due to the lack of strategies for dissemination and commercialization by the entities regulating this sector. In 2015 there were around 11,000 registered beekeepers in Portugal, who had approximately 33,000 apiaries and 626,000 hives, as presented in Table 1 [1].

Table 1. Generic Characterization of Beekeeping Activity in Portugal.

	2013	2015	Variation (no. and Percentage)	
no. of beekeepers	16,774	10,698	−6,076	−36%
no. of apiaries	40,176	33.876	−6,300	−19%
no. of hives	566,793	626,399	59,606	10%
Apiaries/beekeeper	2	3		
Hives/beekeeper	34	59		

Concerning bee venom, there is no national legislation for its production or marketing, unlike honey. The market is almost non-existent, although consumers would be industries [2,4,9,10] that use molecules present in this substance for the treatment of various diseases, or for cosmetic purposes. The market value of this product was more than 23,000 Euros/kg in 2009 [1], but the collectors present in the Portuguese market have a very low yield and the index of contamination is quite high. The main reason is the fact that external equipment is the main device used for this collection [23]. The inside collector types are not used in Portugal, because those devices are manufactured with materials that do not meet the minimum legal Portuguese requirements, for products related to human consumption.

3. Methodology

To validate the interest in the proposed equipment, three main pieces of information need to be collected, and will be addressed in the Methodology Section. First, a characterization of potential users and its dimension is addressed. Secondly, the design of an intensive bee venom collector is implemented and tested, with the purpose of validating the increase of productivity and quality, relatively to actual state-of-the-art equipment available on the market. Thirdly, the financial outcome of the new collector is analyzed, in order to evaluate its potential interest for beekeepers.

3.1. Source of Data

To determine if there are Portuguese beekeepers interested in this type of exploration, a preliminary questionnaire (see Appendix A), was elaborated for a confidence interval of 99% and

a sample error of 10%, obtaining a sample of 164 beekeepers to be interviewed. Since it is a national analysis, the sample was stratified using the expression (1):

$$n = \frac{N \cdot Z^2 \cdot p \cdot (1-p))}{Z^2 \, p \cdot (1-p) + e^2 \, (N-1)} \quad (1)$$

where n is the calculated sample, N the total population, Z the standardized normal variable associated with the confidence interval, p the true event probability and e the sampling error.

According to the sample of beekeepers in Portugal mentioned in Table 1, it is necessary to gather data on how they are distributed geographically along the country. The only reliable information found concerns *"The National Beekeeping Program 2017–2019"*, responsibility of the Portuguese Government, and, as can be seen in Table 2, the majority of them are in the north and center of the country. This situation is mainly due to its relationship with agriculture, since those regions are the main areas of crops related to the pollination process [1]. To take a representative sample from the questionnaire, we need to know how many beekeepers are needed by region, so results were merged, and are also presented in Table 2.

Table 2. Absolute Value of the Sample for a 99% confidence Interval and a sampling error of 10%.

Region	Absolute Value	% of Region	Absolute Sample Value
North	3,657	34%	56
Center	3,549	33%	54
Lisbon and Tagus Valley	910	9%	15
Alentejo	1,214	11%	18
Algarve	837	8%	13
Autonomous Region of Madeira	346	3%	5
Autonomous Region of Azores	185	2%	3
		Total	164

The design of the new proposed bee venom collector implements several novel features in comparison with state-of-the-art equipment [25]. The main novelty is the placement of the collector in a vertical position, taking in consideration that the viscosity of the bee venom will prevent it sliding down the glass. Consequently, the new collector will have electrical filaments in both sides of the glass, immediately duplicating the contact area. A power control unit, battery powered, will generate the electrical pulses and control the current flow to keep the bees healthy (Figure1). Power control parameterization has been the subject of several studies [17,26,27]. In terms of voltage, frequency and current limit, the proposed equipment considered the optimal values from the work of Maulana et al. [28].

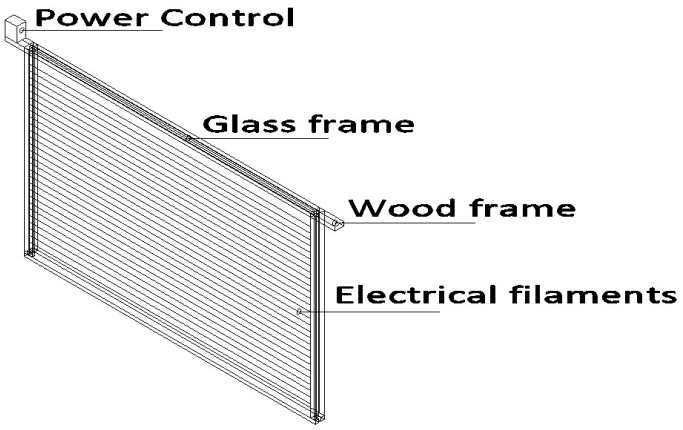

Figure 1. Individual Frame with Two Contact Sides.

On a second stage, 10 frames with glass plates are placed inside the hive (Figure 2) in a box similar to honey frames collector boxes.

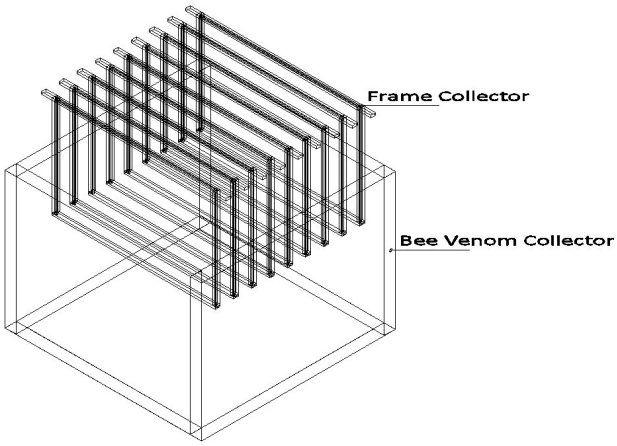

Figure 2. Collector with 10 Internal Frames.

Finally, the collector is placed inside, on the top of the beehive, to collect venom from a larger number of bees, and preventing the product from being contaminated by outside agents. The clipboard and the cover of the hive are placed over it, as shown in Figure 3.

To build this prototype, an investment of 593 Euros was made. The collector has 10 frames with a unitary contact area of 24 cm × 33 cm by side, providing a contact area of 792 cm^2, which means that each frame provides 1584 cm^2 in both sides, and the global collector 15,840 cm^2. Filaments are separated by a distance of 3.5 mm, being powered by two AA batteries. To compare the results obtained with this collector, a state-of-the-art collector was acquired from Multi-Sweet (Group) Co. Limited, at cost of 263 Euros. The collector has measurements of 33 cm ×x 33 cm, providing a total contact area of 1089 cm^2 and filaments are separated by a distance of 3.5 mm, being powered by a lithium battery. This collector was used in a similar hive to the one used with the new collector. In this way, we tried to provide similar conditions of operation to both collectors, in order to analyze properly the results obtained. The equipment was tested during the spring (May and June), in the morning, at 8AM, for a 1 h period daily. Every three days, a three-day stop was made, to lower stress in the beehives, since the venom was collected for a total of 16 days per month.

The productivity analysis was made by comparing the quantity obtained in each collector, and a qualitative analysis regarded the quality of bee venom. The data used for the financial analysis were the market prices of bee venom and the usual costs among beekeepers: labor, tools, wear, and cleaning products. Concerning the investment by collectors, the state of the art was bought on the international market and the new one was the sum of components bought plus the labor costs involved.

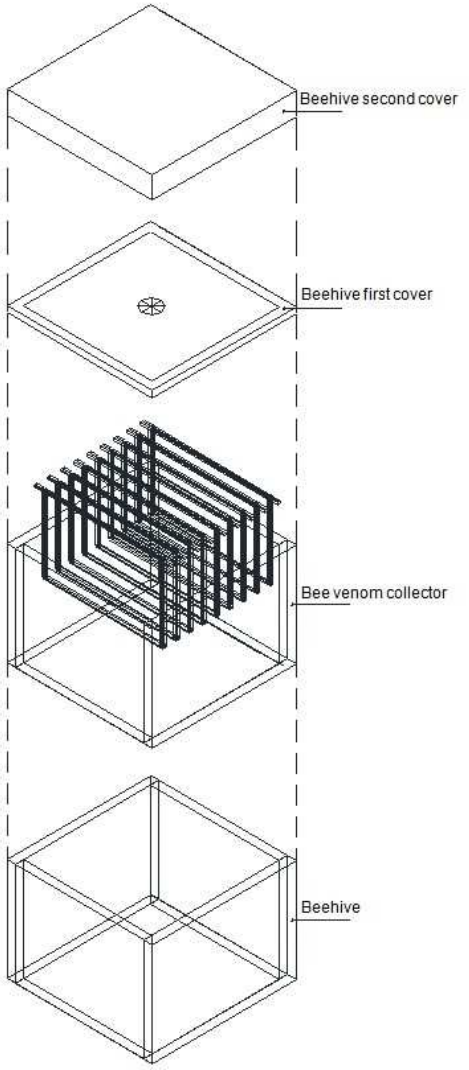

Figure 3. Intensive Collector Application.

3.2. Data Analysis

The questionnaire regarding beekeeper characterization was provided in Portuguese, from 2 November 2018 to 17 February 2019, in all social network groups of beekeepers and in all beekeeper associations in Portugal, including the islands (25 associations and the National Federation of Beekeepers of Portugal). Although only 164 would be necessary to satisfy the sample value for a 99% confidence interval and a sampling error of 10% (Table 2), all valid answers were considered in the present work.

Accordingly, with the questionnaire, the data was organized to highlight the weight (as a percentage) of the different classes of beekeepers, number of hives and their information and interest on bee venom. The trustworthiness of the data on beekeepers was controlled by comparing their self-classification with the number of hives reported. The experiment with both collectors consisted of the daily collection of bee venom, adequate packing, and sending to a certificated laboratory to measure the quantity and control the quality. This information was registered systematically to enable the discussion of results. To evaluate the financial interest of the new collector, a Comparative Income Statement (CIS), traditionally known as trading and profit and loss, was performed. Compared with other similar approaches, e.g., the Pyramid Method, mostly based on trend analysis CIS, allows the study and obtaining of a global scenario of the overall profitability of the business, observing its

periodic performance evaluation. The main disadvantages are the fact that it ignores inflationary impacts and has high dependability on financial information, which in the present case has a minor effect. Therefore, a comparison was made between several variables applied to both collectors used in the experiment: investments, operational costs, incomes, profits, and cash flows inherent to each solution. The operational cost included tools and utensils for fast wear, cleaning, hygiene, and comfort, and labor and amortizations. After gathering these data, some analyses were made: Net Present Value (NPV), the difference between the present value of cash inflows and the present value of cash outflows over a period of time; Internal Rate of Return (IRR), metric used to estimate the profitability of potential investments, a discount rate that makes the net present value of all cash flows from a particular project equal to zero; and the Payback Period, which refers to the amount of time it takes to recover the cost of an investment.

4. Experimental Results

4.1. Beekeeper Characterization

A total of 207 valid answers were collected from all the channels used for the questionnaire dissemination, validating the statistical assumption. Despite its global validity, since question 1.2 (see Appendix A) addressed the region of activity of the beekeeper, the sampling methodology was also validated by region, where the obtained results are presented in Table 3 and in Figure 4.

Table 3. Percentages by Region of collected answers.

Region	Predicted Answers	Collected Answers	Obtained Confidence Level	Obtained Error
North	34%	22%	95%	10%
Center	33%	34%	99%	10%
Lisbon and Tagus Valley	9%	9%	99%	10%
Alentejo	11%	27%	99%	6%
Algarve	8%	5%	95%	10%
Autonomous Region of Madeira	3%	1%	90%	10%
Autonomous Region of Azores	2%	2%	99%	10%

As can be verified by the analysis of Table 3, the total expected answers were obtained to satisfy the assumed statistical values; when scrutinized by region, some differences can be found. The error of the sampling of the population was achieved, and even decreased for Alentejo region. Regarding the confidence interval, due to the lack of expected answers in some regions, some values decreased, while remaining within the usual and acceptable values in the context of our work.

Considering all valid answers obtained, the first interpretation is the fact that the type of beekeeping practiced, by the universe of obtained answers, is mostly a hobby activity (Table 4).

To understand the reason that leads to 70% of beekeepers performing it as a hobby activity, their size was evaluated as an indicator of their individual production. The question under scrutiny was the number of hives a producer has. Obtained results show that most of them have very few hives (72% have less than 101 hives), as shown in Table 4. It was also questioned if beekeepers collected bee venom, to which only 3% answered affirmatively, as shown in Table 4. From here, the first observation points to bee venom production not being an activity considered among beekeepers.

Also, Table 4 shows that 97% of those surveyed did not collect bee venom; this value is too high, so it was pertinent to pursuit the motivations that led them not to do so. From the proposed questionnaire it was verified that 44% do not know the processes to perform this type of activity, or even do not know what bee venom is. With the bee venom market at a very embryonic stage in Portugal, beekeepers were asked about their interest in exploiting it, to which 65% answered affirmatively as shown in Table 4. As there are several segments of beekeepers, as shown in Table 4, we identified which segments would be most interested in collecting bee venom. Once there is a significant interest

in bee venom collection detected through the questionnaire, and considering the market size evaluated, an intensive collector prototype was developed. The purpose of such development and investment was to test if it was possible to collect bee venom in a more economical way and, consequently, with a higher yield. In order to validate the results obtained from the production of the new intensive collector, a comparison was made with a state-of-the-art collector, placed as cover inside the beehive.

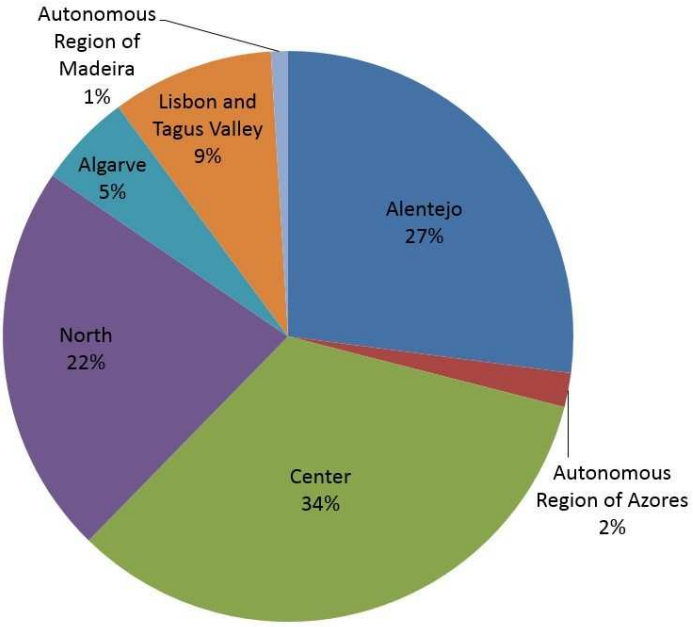

Figure 4. Percentages by Region of collected answers.

Table 4. Data collected from the applied questionnaire.

Variable	Category	Frequency	Percentage
Type of bee practiced	Hobby	145	70%
	Professional	62	30%
Size of bee venom production	1–10 beehives	60	29%
	11–25 beehives	33	16%
	26–50 beehives	25	12%
	51–100 beehives	31	15%
	101–200 beehives	23	11%
	201–500 beehives	24	12%
	More than 500 beehives	11	5%
Collection of bee venom	Yes	7	3%
	No	200	97%
Reasons for not collecting bee venom	You do not know the techniques to do it	82	40%
	it is a complicated process	18	9%
	I'm not interested in this practice	37	18%
	It requires a lot of time	27	13%
	Collectors in the market have very high prices	32	16%
	Do not know what apitoxin is	7	4%
Interest in collecting bee venom	Yes	134	65%
	No	73	35%
Interest in collecting bee venom in different segments of beekeepers	1–10 beehives	37	27%
	11–25 beehives	22	16%
	26–50 beehives	19	14%
	51–100 beehives	18	13%
	101–200 beehives	17	12%
	201–500 beehives	16	12%
	More than 500 beehives	8	6%

4.2. State-of-the-Art Bee Venom Collector

After a month using the equipment in the field, as described above, always in the same beehive, 272 mg of bee venom was collected. Every day, the bee venom was dried, and removed from the glass plates, with the help of an appropriate spatula to remove it, always using the necessary protective equipment to avoid contamination and direct contact with the skin (Figure 5 a).

Figure 5. (**a**) Bee Venom Removal (**b**) Bee Venom Collected (intermediate container).

After being collected and placed in an intermediate container, the substance was packaged in an opaque container, and placed in a dry environment away from sunlight, until measured and controlled in quality by a certificated laboratory (Figure 5 b).

4.3. Intensive Bee Venom Collector

The new device developed and described in Section 3.2 was subject to the exact same testing conditions, with a prototype being assembled to perform the field experiments, representing an investment of 593 Euros. The collector has 10 frames with a unitary contact area of 24 × 33 cm by side, providing a contact area of 792 cm^2, which means that each frame provides 1,584 cm^2 in both sides, and the global collector 15,840 cm^2. Filaments are also separated by a distance of 3.5 mm, being powered by two AA batteries. The same procedure was used with the intensive collector, but with a different positioning regarding the beehive. The collector was placed over the hive and it was covered (Figure 3). In the same period of time, 4,266 mg of bee venom was collected. Figure 6 shows the extraction of one frame from the beehive.

Figure 6. Equipment Application in Real Environment.

As previously, the bee venom was dried, and removed from the glass plates. It was observed that the bee venom collected had fewer contaminating particles, and it was spread for all over the glass plates. After the substance was collected it was packaged in a clean opaque container for further weight measurement and quality control.

5. Productivity and Profitability Analysis

In the present section, some analyses are performed to determine the project's feasibility.

5.1. Data Preparation and Productivity Analysis

Our starting point was to compare the conditions and results obtained with the two collectors under study, as can be seen in Table 5.

Table 5. Conditions and Results Obtained.

Items	State-of-the-Art Collector	Intensive Collector	Difference
Production			
Area (cm^2)	1089	15,840	14,751
Production (mg)	272	4266	3994
Price of collectors (Euros)	263	593	330
Productivity (mg/cm^2)	0.24977	0.26932	0.01955
Annual production (mg)	3264	51,192	47,928
Working operating times			
Operating minutes/collector	3	30	27
Operating minutes/month	48	480	432
Operating days/month	0.11	1.07	0.96
Amortizations (constant quotas)			
Year of lifespan	8	8	
Yearly amortization	32.88	74.13	41.25

It is important to note that the price of the intensive collector is based on the amount spent to make a prototype, which means that under large production scales it is possible to lower its price. Under a qualitative perspective, it was noted that the bee venom collected with the intensive collector had less contamination all along the experiments period, which means that can achieve better market prices. Accordingly to these data, it can be verified that the increase in production is similar to the increase in collecting area, with some advantage for the increase in production (15.68 times) times more production versus 14.55 times more collecting area). This means the productivity is higher with the intensive collector, as presented in Table5.

The increase in production also represented a strong increase in absolute quantity, and the major achievement is the fact that the increase in the amount of investment needed to achieve these results is much lower comparatively—only 2.26 times—which is a much lower increase in comparison to the one of production.

To analyze the profitability, the results obtained were extrapolated for an annual period, as presented in Table 5.

Because the state-of-the-art collector has only one piece to be operated, while with the intensive collector has 10 pieces or more (10 collecting frames and the beehive first cover, which is the collector in the first solution), the working operating times are higher in the new collector. This consequence is as presented in Table 5, were 16 collecting days per month are considered.

The amortizations of both collectors are presented also in Table 5.

To analyze the viability of both collectors, the general assumptions in the context of Portuguese beekeeping activity are presented in Table 6, considering also that the monetary unit is the Euro. The usual parameters to perform quantitative analyses were considered, namely inflation (2%), the

purchase price of bee venom (23 €/g), the number of working hours (7.5 h), the human resources cost (34 €/day), among several other indicators.

Table 6. General Assumptions.

General Assumptions	
Constant annual Inflation (%)	2
Price of Bee Venom (Euros/g)	23
Working hours/day	7.5
Labor daily cost (Euros)	34
Taxes on Labor Costs	24.75%
Taxes on Profits	25%
Interest rate of risk-free assets—Rf	1%
Market risk premium—(Rm-Rf) or p^0	1.33%

5.2. Profitability Analysis

Starting with the state-of-the-art collector analysis in Table 7, sales, costs, and profitability are presented with the help of the information presented previously.

Table 7. State-of-the-art Collector.

Years	Year 1	Year 2	Year 3	Year 4	Year 5
Rate of change of prices		2.00%	2.00%	2.00%	2.00%
Sales (Euros)					
Quantities Sold (g)	3.264	3.264	3.264	3.264	3.264
Unit Price (Euros)	23.00	23.46	23.93	24.41	24,90
Total sales	75	77	78	80	81
Costs (Euros)					
Tools and utensils for fast wear	3	3	4	4	4
Cleaning, hygiene and comfort	6	6	6	7	7
Labor	65	67	68	69	70
Costs (except amortizations)	74	76	77	80	81
Amortizations	33	33	33	33	33
Total costs	107	109	110	113	114
EBITDA [1]	1	1	0	0	0
EBIT (Earnings Before Interest and Taxes)	-32	-32	-33	-33	-33
Tax over the period's income	0	0	0	0	0
Net Income for The Period	-32	-32	-33	-33	-33
Operating Cash Flow	1	1	0	0	0
Fixed Assets' Investments	263				
Free Cash Flow	−262	1	0	0	0
Accumulated Cash Flow	−262	−261	−261	−261	−261

[1] Income before depreciation.

Accordingly to the data presented in Table 7, the profitability is marginal and does not have the capacity to recover the investment on the collector, or only in a very marginal way (2 Euros), and the cash flow reflects this consideration.

The IRR (Internal Rate of Return) is negative, where a value of −94% was obtained, in accordance with the calculated NVP, as shown in Table 8. Due to the low production of the collector under analysis, the total sales income does not cover the necessary initial investment. Basically, the sum of post-investment cash flows is less than the initial investment, and the investment loses money at the rate of the negative IRR.

Table 8. State-of-the-art Collector's Indicators (Euros).

NPV (Euros)	−211
Payback Period (Years)	-
IRR (%)	−94

The intensive collector analysis starts with Table 9, where sales, costs, and profitability are presented with the help of the information presented previously.

Table 9. Intensive Collector.

Years	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Rate of change of prices		2.00%	2.00%	2.00%	2.00%
Sales (Euros)					
Quantities Sold (g)	51.192	51.192	51.192	51.192	51.192
Unit Price (Euros)	23.00	23.46	23.93	24.41	24.90
Total sales	1177	1201	1225	1249	1274
Costs (Euros)					
Tools and utensils for fast wear	54	56	58	59	61
Cleaning, hygiene and comfort	24	25	25	26	27
Labor	635	648	661	674	688
Costs (except amortizations)	713	729	744	759	776
Amortizations	74	74	74	74	74
Total costs	787	803	818	833	850
EBITDA [1]	464	472	481	490	498
EBIT	390	398	407	416	424
Tax over the period's income	97	100	102	104	106
Net Income for The Period	293	298	305	312	318
Operating Cash Flow	367	372	379	386	392
Fixed Assets' Investments	593				
Free Cash Flow	−226	372	379	386	392
Accumulated Cash Flow	−226	146	525	911	1303

[1] Income before depreciation.

Accordingly, with these data presented in Table 9 the profitability is positive, including under a tax perspective, with a strong capacity to generate cash flow.

The NPV is positive, the payback period is very fast (less than 2 years), and the IRR is positive too. These values are presented in Table 10.

Table 10. Intensive Collector's Indicators (Euros).

NPV (Euros)	568
Payback Period (Years)	1.61
IRR (%)	163

6. Discussion

According to the results obtained from the questionnaire, it is clear that bee venom collection is marginal in Portugal and many beekeepers do not even know of its existence as a commercial product, despite its commercial value and interest in the pharmaceutical and cosmetic markets. In Table 11 we compare some data obtained from the productivity and profitability analysis made previously.

Table 11. Compared Results.

	State-of-the-Art Collector	Intensive Collector
Annual quantities (g)	3.264	51.192
Sales (5 years, Euros)	391	6126
Costs (5 years, Euros)	553	4090
Accumulated Cash Flow (Euros)	−261	1303
NPV (Euros)	-211	568
Payback Period (years)	-	1.61
IRR (%)	−94	163

As can be seen, one situation is potentially profitable—the intensive collector—and the other is not, in the Portuguese context, because, mostly, of the labor costs involved together with the low production obtained. Due to the low production of the collector under analysis, the total sales income does not cover the necessary initial investment, only the operational costs. Basically, the sum of post-investment cash flow is less than the initial investment, and the investment loses money at the rate of the negative IRR.

It is important to note that the price of the intensive collector is based on the amount spent to make a prototype, which means that under large production scales it is possible to lower its price. Under a qualitative perspective it was noted that the bee venom collected with the intensive collector had less contamination all along the experimental period, which means that can achieve better market prices.

As previously mentioned, there is a 65% interest from the beekeepers surveyed; extrapolating to the universe of beekeepers in Portugal, this interest corresponds to 6,954 beekeepers who hold around 407,159 hives. With the intensive collector it is possible to collect annually, from a beehive, 51.192 g, which corresponds to an annual commercial value of 1177 Euros/beehive. With 407,159 beehives it is possible to collect approximately 20,843 kg/year, which corresponds to a commercial value of 479,396 Euros. This extra annual income that can be withdrawn from the hive can represent an interesting increase in income for beekeepers, to add to the incomes derived from the other products, namely the honey.

Accordingly, with these considerations, we consider it is worth it to further develop/refine our first prototype, to increase the yields obtained and to design the frames in order to enable their efficient mass production. The purpose would making it possible to lower the initial investment on their purchase. As we can verify, there is a market ready to be developed.

7. Conclusions

The purpose of this work was related to the market of bee venom in Portugal, its expression and the productivity and profitability analysis of a new intensive bee venom collector. After analyzing the data available, it was realized that bee venom is a very important substance and has great value in the global pharmaceutical and cosmetic markets. However, in Portugal the bee venom sector is quite not explored, although there is interest in Portuguese beekeepers pursuing to this practice, according to data obtained in the questionnaire, which corresponds to 65% of the answers. Since there is a significant interest in bee venom collection and considering the market size evaluated, an intensive collector prototype was developed. The purpose of such development and investment was to test if it was possible to collect bee venom in a more economical way in the Portuguese context.

To validate the results obtained from the production of a new intensive collector, a comparison was made with a state-of-the-art collector, placed as cover inside the beehive. Through the experimental test, it could be verified that, effectively, bee venom was cleaner, and productivity is higher with the new collector. Although the cost of the equipment is higher too, it is possible to achieve return on investment in a short time, and get a better income in the beekeeping activity, which amount will depend on size and operation efficiency.

The results obtained showed also that the state-of-the-art collector was not profitable in the Portuguese context, because of the conjunction of lower production with high labor costs, meaning a difficult situation among advanced economies, where labor costs are usually higher. That is why we think intensive equipment is important in the context of advanced economies with higher labor costs. On the other hand, the economic risks are usually lower when we deal with relevant quantities, and the opposite when they are marginal, as is the case of the state-of-the-art collector.

Due to the lack of knowledge among beekeepers, the need for commercial and technical workshops to disseminate the activity to potential users should also be considered as future work. It is emphasized that the proposed product is not protected by intellectual property, which means that any association or trader is free to develop the mass production and marketing of the product.

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Appendix A. Questionnaire—Technology in Beekeeping

Dear Sir / Madam,

We thank you for 7 min of your willingness time to answer to a simple questionnaire related to beekeeping activity, and your opinion on a new technology under study.

The answers will be completely anonymous and your collaboration is essential, to contribute on the development of a technology that can best satisfy this sector of activity.

1. General data

1.1. Are you a beekeeper?

Yes	
No	

(Finish questionnaire)

1.2. In what region are you located?

North	
Center	
Lisbon and Tagus Valley	
Alentejo	
Algarve	
Autonomous Region of the Azores	

1.3. What kind of beekeeping do you practice?

Hobby	
Professional	

1.4. How many hives do you have?

Between 1 and 10	
Between 11 and 25	
Between 26 and 50	
Between 51 and 100	
Between 101 and 200	
Between 201 and 500	
More than 500	

1.5. What products do you get from your beekeeping activity?

Honey	
Pollen	
Propolis	
Beeswax	
Bee venom	
Royal jelly	

2. Bee venom

Bee venom is the poison produced by bees, increasingly used in the treatment of various diseases, such as cancer, AIDS, Parkinson's, multiple sclerosis, among others. Bee venom is composed of several substances capable of damaging the viruses responsible for causing the diseases mentioned. It gives its importance in the current market.

Although it is a substance that is not often produced or marketed in the Portuguese market, it is the one that has the highest market value in relation to all other products that can be obtained from bee farms.

2.1. Do you collect bee venom on your farm?

Yes		(Go to 3.)
No		

2.1.1. Why?

You do not know the techniques to do it		
It's a complicated process		
I'm not interested in this practice		(Finish questionnaire)
It requires a lot of time		
Collectors in the market have very high prices		
Do not know what bee venom is		

2.2. Would you be interested in exploring the bee venom market?

Yes		
No		(Finish questionnaire)

3. Bee Venom Collectors

Collector A	Collector B
Image 1	Image 2

3.1. Are you familiar with the collectors that appear in the image?

Yes	
No	

3.2. Do you use this equipment to collect bee venom?

Yes	
No	

3.3. Do you use other equipment to collect bee venom?

Yes	
No	

3.4. How many milligrams of bee venom do you usually get per hive on your farm?

<100 mg	
100 mg	
>100 mg	
I do not collect bee venom	

4. New Technology in Study

Equipment for the collection of bee venom is under study that, compared to the current equipment, has a yield approximately 5 times higher.
We now ask for your opinion on the purchase of this equipment.

4.1. Would you be willing to buy this higher-yielding equipment to collect bee venom?

Yes	
No	

(Finish questionnaire)

4.2. What price would you be willing to pay for this equipment?

	Would buy	Weights Buy	Would not buy
Less than 400 euros			
Between 400 and 500 euros			
Between 501 and 600 euros			
More than 600 euros			

Thanks for your collaboration!

If you would like more information on this topic, please leave us your contact.

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CAPÍTULO III – CONCLUSÕES

O estudo apresentado teve como objetivos a análise do mercado português relativamente ao seu conhecimento sobre a apitoxina; a análise do interesse dos apicultores portugueses na recolha de apitoxina; desenvolver um protótipo de coletor intensivo de apitoxina; e a análise da produtividade e viabilidade económica do protótipo.

De forma a melhor enquadrar a investigação, realizou-se inicialmente uma revisão da literatura sobre o mercado da apitoxina, incluindo em Portugal, verificando-se a existência de patentes relativamente aos coletores e um considerável número de aplicações que a apitoxina pode ter em diversos mercados.

Neste processo verificou-se que a informação sobre o mercado português era muito incipiente e já com alguns anos. No entanto, face aos valores que a apitoxina tem em diversos mercados e ao interesse que a mesma tem para um vasto e diversificado número de aplicações, considerou-se que valeria a pena tentar ultrapassar esta lacuna de informação e tentar verificar se haveria viabilidade de explorar este produto no mercado português.

Neste sentido, o estudo empírico envolveu a aplicação de um questionário aos apicultores portugueses para se tentar responder aos dois primeiros objetivos do mesmo. As respostas obtidas não espelharam totalmente a representatividade das várias regiões do país, mas as diferenças registadas não põem em causa os resultados obtidos e respetiva interpretação. Com efeito, este estudo teve por base uma amostra probabilística, que permite extrapolar para a totalidade de apicultores portugueses, já que os dados recolhidos abrangeram todo o continente português e ilhas. Apesar disso existem algumas limitações, relativamente ao nível de confiança e erro amostral, pois existem variações em algumas regiões, umas por excesso outras por defeito.

Contudo, apesar das limitações identificadas, considera-se que o estudo permitiu conhecer melhor o mercado português sobre recolha de apitoxina, e interesse na mesma.

Com efeito, com base nos dados obtidos conclui-se que se trata de um mercado marginal, grandemente desconhecido para a maior parte dos apicultores, mas que os mesmos, independentemente da sua dimensão, estariam interessados em aproveitar. Neste ponto, da revisão da literatura desenvolvida, constatou-se que nem em Portugal nem na Europa esta situação está devidamente acautelada a nível legislativo e de divulgação por parte das entidades oficiais.

Em face destes resultados e das escassas quantidades que se obtêm dos coletores existentes no mercado, para além de diversos problemas enfrentados pelos mesmos referidos na literatura consultada, considerou-se oportuno e interessante tentar desenvolver um novo coletor que permitisse ultrapassar as deficiências registadas, o que representa a concretização do terceiro objetivo do estudo.

Tendo em consideração as limitações que uma exploração adequada das colmeias impõem à recolha de apitoxina, no sentido de não por em causa as suas operações normais, desenvolveu-se um coletor que utiliza as mesmas tecnologias de base dos que existem no mercado, mas através de um maior número de quadros de recolha e localizados diretamente sobre o módulo que alberga a colmeia. Daí que se tenha denominado este coletor de "intensivo", uma vez que se passa de uma superfície de recolha num dispositivo para dez dispositivos com dupla face, ou seja de uma superfície para vinte superfícies de recolha de apitoxina.

No âmbito da concretização do quarto objetivo do estudo, analisou-se a produtividade obtida, verificando-se que com esta estratégia, efetivamente, aumentou-se consideravelmente a quantidade de apitoxina recolhida em comparação com um coletor que é considerado dos mais eficientes entre os existentes no mercado. Nesta comparação os dois coletores foram utilizados no mesmo período, na mesma localização sob condições semelhantes e em duas colmeias, também muito semelhantes.

No entanto, o amento das quantidades recolhidas não foi proporcional ao aumento de área de recolha, foi inferior (cerca de quinze vezes superior em comparação com vinte vezes superior), de modo que se revela interessante verificar em futuros estudos se será possível obter um aumento de produção mais aproximado ao aumento de área de recolha proporcionado pelo novo coletor.

Como é natural, face à sua maior dimensão, o novo coletor representa um investimento superior relativamente aos coletores existentes no mercado. No entanto, o acréscimo de investimento não é, também, proporcional ao aumento de área de recolha disponibilizada, sendo inferior. Refira-se, também, que o protótipo desenvolvido foi produzido de uma forma artesanal numa oficina, de modo que o seu custo pode, e deve, baixar se for alvo de um processo de *redesign* e de produção industrializada, o que afetará, positivamente, os resultados obtidos na exploração de apitoxina, graças a um investimento inferior ao que é reportado neste estudo.

Outro fator positivo que se verificou, consistentemente, durante o estudo, consiste numa melhor qualidade da apitoxina recolhida, no sentido que era mais limpa, i.e. com

menos impurezas agregadas. Esta situação pode-se refletir num acréscimo de valor a obter pela apitoxina no mercado.

Na sequência da análise da produtividade realizada procedeu-se a uma análise de rentabilidade para averiguar do interesse económico do novo coletor. Tendo-se concluído que, atendendo às condições de contexto vigentes em Portugal, o coletor existente no mercado não se revelava viável economicamente e que o novo coletor pode proporcionar um acréscimo de rendimento interessante para os apicultores.

As razões para esta discrepância prendem-se com os níveis de custos de mão-de-obra vigentes no país, que representam uma situação comum nas economias mais desenvolvidas, em comparação com as diminutas quantidades recolhidas pelos coletores atuais. Deste modo, as superiores quantidades recolhidas com o novo coletor revelaram-se decisivas para a viabilização deste produto. Esta situação, juntamente com a melhor qualidade obtida e a previsível diminuição do investimento necessário num contexto de industrialização da produção do coletor intensivo, podem constituir as bases para um aumento, relevante, deste mercado em Portugal, com possíveis reflexos noutros setores de atividade, como pode ser o caso do desenvolvimento de produtos nacionais no âmbito da farmacêutica e da cosmética, entre outros.

No âmbito da seção de discussão dos resultados no artigo, extrapolaram-se alguns dados, tendo em conta o interesse detetado no inquérito, para se ter uma ideia da dimensão que o mercado de apitoxina pode ter em Portugal, que se revela interessante.

Perante o conjunto dos resultados obtidos, considera-se que o estudo apresentado pode constituir uma base para futuros desenvolvimentos no sentido de se criar um mercado relevante de apitoxina em Portugal.

Neste sentido, poder-se-á desenvolver o protótipo de forma a se obter um coletor mais eficiente, tanto em termos de custo como de produtividade na recolha de apitoxina, desenvolver legislação que enquadre adequadamente esta atividade (eventualmente em conjunto ou atendendo às iniciativas despoletadas no parlamento europeu), promover ações de divulgação consequentes entre os apicultores, independentemente da sua dimensão, promover investigações sobre novas aplicações da apitoxina por parte de laboratórios e centros de investigação nacionais, entre outras possibilidades.

De forma a facilitar a concretização destas possibilidades, decidiu-se não patentear o novo coletor intensivo que foi desenvolvido e divulgar o estudo numa revista focada em inovação aberta, conforme se caraterizou na introdução.

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